

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listings of Claims:

1-36. (canceled)

37.(currently amended) The A trench-gated MOSFET of Claim 88 formed in a semiconductor substrate of a first conductivity type, the substrate not comprising an epitaxial layer, the trench-gated MOSFET comprising:

at least four trenches, a conductive gate material being disposed in each of the trenches, the gate material in each trench being separated from the semiconductor substrate by a dielectric layer, a first trench being separated from a second trench by a drain first mesa, the second trench being separated from a third trench by a source second mesa, and the third trench being separated from a fourth trench by a drain third mesa;

the source second mesa comprising:

a source region of a second conductivity type opposite to the first conductivity type adjacent a surface of the substrate, the source region having a first doping concentration of the second conductivity type;

a body region of the first conductivity type adjacent the source region and extending across the second mesa, the body region having a junction depth deeper than the source region; and

a high voltage drift region adjacent the body region and extending across the second mesa, the high voltage drift region having a second doping concentration of the second conductivity type;

each of the drain first and third mesas comprising:

a drain region of the second conductivity adjacent a surface of the substrate and extending entirely across the first and third mesas, respectively, the drain region having a third doping concentration of the second conductivity type; and

a well of the second conductivity type adjacent the drain region and extending entirely across the drain first and third mesas, respectively, the well having a fourth doping concentration of the second conductivity type; and

a layer of the second conductivity type, the deep drain layer abutting a bottom of each of the first, second, third and fourth trenches;

wherein the first doping concentration is greater than the second doping concentration and the third doping concentration is greater than the fourth doping concentration.

38.(currently amended) The trench-gated MOSFET of Claim 37 wherein each of the drain first and third mesas comprises a high voltage drift region.

39.(currently amended) The trench-gated MOSFET of Claim 37 comprising a deep second layer of second conductivity type located beneath the drain layer of second conductivity type, the deep second layer having a fifth doping concentration.

40.(previously presented) The trench-gated MOSFET of Claim 39 wherein the fifth doping concentration is greater than the fourth doping concentration.

41.(currently amended) The trench-gated MOSFET of Claim 37 wherein the MOSFET comprises an array of cells, each of the cells containing a source mesa or a drain mesa, the cells including mesas similar to the first mesa alternating with cells similar to the second mesa, the mesas being separated by intervening trenches.

42.(previously presented) The trench-gated MOSFET of Claim 41 wherein viewed from above the cells are polygonal.

43.(currently amended) The trench-gated MOSFET of Claim 41 wherein viewed from above the cells are rectangular rectangular.

44.(previously presented) The trench-gated MOSFET of Claim 41 wherein viewed from above the cells are square.

45.(previously presented) The trench-gated MOSFET of Claim 41 wherein viewed from above the cells are longitudinal stripes.

46.(previously presented) The trench-gated MOSFET of Claim 41 comprising electrical contacts to respective body regions in the cells, the electrical contacts occurring in a regular and repeated spacing.

47.(previously presented) The trench-gated MOSFET of Claim 37. wherein the body region has a non-Gaussian doping profile in a vertical cross-section.

48.(previously presented) The trench-gated MOSFET of Claim 37 wherein the body region comprises a series of implants formed at differing energies.

49.(previously presented) The trench-gated MOSFET of Claim 37 wherein the body region has a peak doping concentration higher a doping concentration of first conductivity material at the surface of the substrate.

50.(previously presented) The trench-gated MOSFET of Claim 37 wherein the gate comprises two polysilicon layers, formed from different depositions, each of the polysilicon layers being doped with material of the same conductivity type.

51.(previously presented) The trench-gated MOSFET of Claim 37 wherein the at least four trenches are separate from each other.

52.(previously presented) The trench-gated MOSFET of Claim 37 wherein the at least four trenches are part of an array of interconnected trenches.

53.(previously presented) The trench-gated MOSFET of Claim 37 wherein the second mesa comprises a body contact region of the first conductivity type formed in an opening in the source region to facilitate contact to the body region, the body contact region having a sixth doping concentration, a doping concentration of the body contact region at the surface of the substrate being higher than a doping concentration of the body region.

54.(currently amended) The A trench-gated MOSFET of Claim 88 formed in a semiconductor substrate of a first conductivity type, the substrate not comprising an epitaxial layer, the trench-gated MOSFET comprising:

~~at least four trenches, a conductive gate material being disposed in each of the trenches, the gate material in each trench being separated from the semiconductor substrate by a dielectric layer, a first trench being separated from a~~

second trench by a drain first mesa, the second trench being separated from a third trench by a source second mesa, and the third trench being separated from a fourth trench by a drain third mesa;

the source second mesa comprising:

a source region of a second conductivity type opposite to the first conductivity type adjacent a surface of the substrate, the source region having a first doping concentration of the second conductivity type;

a body region of the first conductivity type adjacent the source region and extending across the souce second mesa, the body region having a junction depth deeper than the source region; and

a high voltage drift region adjacent the body region and extending across the source second mesa, the high voltage drift region having a second doping concentration of the second conductivity type;

each of the drain first and third mesas comprising:

a drain region of the second conductivity adjacent a surface of the substrate and extending entirely across the drain first and third mesas, respectively, the drain region having a third doping concentration of the second conductivity type; and

a well of the second conductivity type adjacent the drain region and extending entirely across the drain first and third mesas, respectively, the well having a fourth doping concentration of the second conductivity type; and

the deep drain layer comprising:

a first layer of the second conductivity type, the first layer abutting a bottom of each of the first and second trenches and the high voltage drift region; and

a second layer of the second conductivity type, the second layer abutting a bottom of each of the third and fourth trenches and the high voltage drift region, the first layer being spaced apart from the second layer;

wherein the first doping concentration is greater than the second doping concentration and the third doping concentration is greater than the fourth doping concentration.

55. (currently amended) The trench-gated MOSFET of Claim 54 wherein each of the drain first and third mesas comprises a high voltage drift region.

56. (previously presented) The trench-gated MOSFET of Claim 54 comprising a deep third layer of second conductivity type located beneath the first and second layers of second conductivity type, the deep third layer having a fifth doping concentration.

57. (previously presented) The trench-gated MOSFET of Claim 56 wherein the fifth doping concentration is greater than the fourth doping concentration.

58. (currently amended) The trench-gated MOSFET of Claim 54 wherein the MOSFET comprises an array of cells, each of the cell containing a source mesa or a drain mesa, the cells including mesas similar to the first mesa alternating with cells similar to the second mesa, the mesas being separated by intervening trenches.

59. (previously presented) The trench-gated MOSFET of Claim 58 wherein viewed from above the cells are polygonal.

60. (previously presented) The trench-gated MOSFET of Claim 58 wherein viewed from above the cells are rectangular.

61. (previously presented) The trench-gated MOSFET of Claim 58 wherein viewed from above the cells are square.

62. (previously presented) The trench-gated MOSFET of Claim 58 wherein viewed from above the cells are longitudinal stripes.

63. (previously presented) The trench-gated MOSFET of Claim 58 comprising electrical contacts to respective body regions in the cells, the electrical contacts occurring in a regular and repeated spacing.

64. (previously presented) The trench-gated MOSFET of Claim 54 wherein the body region has a non-Gaussian doping profile in a vertical cross-section.

65. (previously presented) The trench-gated MOSFET of Claim 54 wherein the body region comprises a series of implants formed at differing energies.

66.(previously presented) The trench-gated MOSFET of Claim 54 wherein the body region has a peak doping concentration higher a doping concentration of first conductivity material at the surface of the substrate.

67.(previously presented) The trench-gated MOSFET of Claim 54 wherein the gate comprises two polysilicon layers, formed from different depositions, each of the polysilicon layers being doped with material of the same conductivity type.

68.(currently amended) The trench-gated MOSFET of Claim 54 wherein the at least four trenches are separate from each other part of an array of interconnected trenches.

69.(previously presented) The trench-gated MOSFET of Claim 54 wherein the at least four trenches are part of an array of interconnected trenches.

70.(currently amended) The trench-gated MOSFET of Claim 54 wherein the source second mesa comprises a body contact region of the first conductivity type formed in an opening in the source region to facilitate contact to the body region, the body contact region having a sixth doping concentration, a doping concentration of the body contact region at the surface of the substrate being higher than a doping concentration of the body region.

71.(currently amended) The A trench-gated MOSFET of Claim 88 formed in a semiconductor substrate of a first conductivity type, the substrate not comprising an epitaxial layer, the trench-gated MOSFET comprising:

at least four trenches formed at a surface of the substrate, the gate material in each trench being separated from the semiconductor substrate by a dielectric layer, a first trench being separated from a second trench by a drain first mesa, the second trench being separated from a third trench by a source second mesa, and the third trench being separated from a fourth trench by a source third mesa;

the drain first mesa comprising:

a drain region of a second conductivity opposite to the first conductivity type adjacent a surface of the substrate and extending across the drain first mesa, the drain region having a first doping concentration of the second conductivity type; and

a well of the second conductivity type adjacent the drain region and extending across the drain first mesa, the well having a second doping concentration of the second conductivity type; each of the source second and third mesas comprising:

a source region of the second conductivity type adjacent a surface of the substrate, the source region having a third doping concentration of the second conductivity type;

a body region of the first conductivity type adjacent the source region and extending across the source second and third mesas, respectively, the body region having a junction depth deeper than the source region; and

a high voltage drift region adjacent the body region and extending across each of the source mesas second mesa, the high voltage drift region having a second doping concentration of the second conductivity type;

~~a layer of the second conductivity type, the layer abutting a bottom of each of the first, second, third and fourth trenches;~~

wherein the first doping concentration is greater than the second doping concentration and the third doping concentration is greater than the fourth doping concentration.

72.(currently amended) The trench-gated MOSFET of Claim 71 wherein the drain first mesa comprises a high voltage drift region.

73.(currently amended) The trench-gated MOSFET of Claim 71 comprising a deep second layer of second conductivity type located beneath the deep drain layer of second conductivity type, the deep second layer having a fifth doping concentration.

74.(previously presented) The trench-gated MOSFET of Claim 73 wherein the fifth doping concentration is greater than the fourth doping concentration.

75.(currently amended) The trench-gated MOSFET of Claim 71 wherein the MOSFET comprises an array of cells, each of the cells containing a source mesa or a drain mesa, the cells including mesas similar to the first mesa alternating with cells similar to the second mesa, the mesas being separated by intervening trenches.

76.(previously presented) The trench-gated MOSFET of Claim 75 wherein viewed from above the cells are polygonal.

77.(previously presented) The trench-gated MOSFET of Claim 75 wherein viewed from above the cells are rectangular.

78.(previously presented) The trench-gated MOSFET of Claim 75 wherein viewed from above the cells are square.

79.(previously presented) The trench-gated MOSFET of Claim 75 wherein viewed from above the cells are longitudinal stripes.

80.(previously presented) The trench-gated MOSFET of Claim 75 comprising electrical contacts to respective body regions in the cells, the electrical contacts occurring in a regular and repeated spacing.

81.(previously presented) The trench-gated MOSFET of Claim 71 wherein the body region has a non-Gaussian doping profile in a vertical cross-section.

82.(previously presented) The trench-gated MOSFET of Claim 71 wherein the body region comprises a series of implants formed at differing energies.

83.(previously presented) The trench-gated MOSFET of Claim 71 wherein the body region has a peak doping concentration higher a doping concentration of first conductivity material at the surface of the substrate.

84.(previously presented) The trench-gated MOSFET of Claim 71 wherein the gate comprises two polysilicon layers, formed from different depositions, each of the polysilicon layers being doped with material of the same conductivity type.

85.(currently amended) The trench-gated MOSFET of Claim 71 wherein the at least four trenches are separate from each other part of an array of interconnected trenches.

86.(previously presented) The trench-gated MOSFET of Claim 71 wherein the at least four trenches are part of an array of interconnected trenches.

87.(currently amended) The trench-gated MOSFET of Claim 71 wherein each of the source second and third mesas comprises a body contact region of the first

conductivity type formed in an opening in the source region to facilitate contact to the body region, the body contact region having a sixth doping concentration, a doping concentration of the body contact region at the surface of the substrate being higher than a doping concentration of the body region.

88. (previously presented) A trench-gated MOSFET formed in a semiconductor substrate of a first conductivity type, the substrate not comprising an epitaxial layer, the trench-gated MOSFET comprising:

an array of trenches formed at a surface of the substrate, the trenches forming and defining plurality of mesas, the plurality of mesas including source mesas and drain mesas;

each trench holding a conductive gate material, the gate material in each trench being separated from the substrate by a dielectric layer, and

each drain mesa comprising a column of dopant of the second conductivity type substantially laterally contained by the trenches surrounding the drain mesa, and

each source mesa comprising a three-layer sandwich of alternately doped layers including an upper layer doped with a dopant of the second conductivity type, the upper layer being adjacent the surface of the substrate and acting as a source region, a middle layer doped with a dopant of the first conductivity type, the middle layer acting as a body/channel region, an opening being formed in the upper layer, the opening extending from the surface of the substrate to the middle layer and being filled with a dopant of the first conductivity type to facilitate the biasing of the body/channel region, and a lower layer doped with a dopant of the second conductivity type, the lower layer acting as a drain region, the dopants in the three-layer sandwich being substantially laterally contained by the trenches surrounding the source mesa,

a deep drain layer of the second conductivity type extending beneath the source and drain mesas and having a bottom junction depth deeper than the trenches, wherein the deep drain layer overlaps and is electrically shorted to the column of dopant of the second conductivity type in each of the drain mesas; and to the lower layer in each of the source mesas;

an electrical contact to the column of dopant of second conductivity type in each of the drain mesas;

an electrical contact to the upper layer and the dopant of first conductivity type in the opening in the upper layer in each of the source mesas; and

an electrical contact to the conductive gate material in the trenches.

89. (previously presented) The trench-gated MOSFET of Claim 88 wherein the trenches form an orthogonal grid that separates the source and drain mesas.

90. (previously presented) The trench-gated MOSFET of Claim 88 wherein the mesas are formed into a pattern of cells, each cell including only a single drain mesa and a plurality of source mesas.

91. (previously presented) The trench-gated MOSFET of Claim 88 wherein viewed from above the source and drain mesas are in the form of longitudinal stripes.

92. (previously presented) The trench-gated MOSFET of Claim 88 wherein viewed from above the source and drain mesas are rectangular.

93. (previously presented) The trench-gated MOSFET of Claim 88 wherein viewed from above the source and drain mesas are square.

94. (previously presented) The trench-gated MOSFET of Claim 88 wherein viewed from above the source and drain mesas are polygonal.

95. (previously presented) The trench-gated MOSFET of Claim 88 wherein the deep drain layer is formed by ion implantation.

96. (previously presented) The trench-gated MOSFET of Claim 88 wherein the deep drain layer has a peak doping concentration at a level deeper than a level of a bottom of the trenches.

97. (previously presented) The trench-gated MOSFET of Claim 88 wherein the deep drain layer has a peak doping concentration higher than a doping concentration of second conductivity type at the surface of the substrate.

98. (previously presented) The trench-gated MOSFET of Claim 88 wherein the column of dopant of the second conductivity type in each drain mesa comprises multiple implants performed at differing energies.

99. (previously presented) The trench-gated MOSFET of Claim 88 wherein the lower layer in each of the source mesas is formed by a high energy ion implantation.

100. (previously presented) The trench-gated MOSFET of Claim 88 wherein the three-layer sandwich in each source mesa is formed by multiple implants performed at differing energies.

101. (previously presented) The trench-gated MOSFET of Claim 88 wherein middle layer of the three-layer sandwich in each source mesa is formed by multiple implants performed at differing energies.

102-103. (canceled)